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Poster

Selecting Moving Targets in AR using Head Orientation

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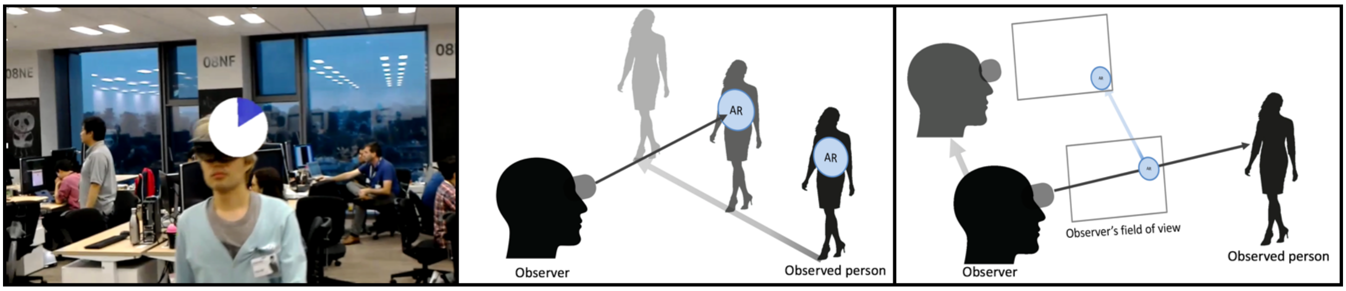

Figure 1: *(left) Example of a participant's view from our user study. (center) Our proposal method TagToPlace: when a user gazes at an AR target, the target is fixed in the real world and stays in place. (right) Our proposal method TagAlong: when a user gazes at an AR target, the target is always displayed within the user's field of view, and the target does not deviate even if the user turns to another direction.*

Abstract

Along with the spread of augmented reality (AR) using head-mounted display or smart glass, attempts have been made to present information by superimposing information on people and things. In general, people are always moving about and usually do not stay stationary, so it is conceivable that the superimposed AR information also moves with them. However, it is often difficult to follow and select moving targets. We propose two novel techniques, TagToPlace and TagAlong, which help users select moving targets using head orientation. We conducted a user study to compare our proposed techniques to a conventional gaze selection method - DwellTime. The results showed that our proposed techniques are superior to a conventional one in terms of throughput when selecting moving targets.

Categories and Subject Descriptors (according to ACM CCS): H.5.1 [INFORMATION INTERFACES AND PRESENTATION (e.g., HCI)]: Multimedia Information Systems—Artificial, augmented, and virtual realities

1. Introduction

With the spread of augmented reality (AR) devices, such as Microsoft HoloLens, which can recognize surrounding environment and objects, more and more information will be superimposed on things and people. For example, it is conceivable to superimpose and display advertisements related to clothes and accessories and show virtual properties. In particular, in a real-world setting such as on the street, the observer or target may not be always stationary. Although selecting objects in AR is a fundamental task, it is difficult for an observer to select a target using head orientation and gesture when the target and observer her/himself are moving. To make it easier to select dynamic targets in AR, we propose two novel moving target selection methods using head orientation and evaluated them in a user study.

2. Related Work

In this study, we examined a method of selecting targets using head orientation only, although it has often been sometimes combined with other methods such as hand gesture. A common pointing and selecting method that uses head orientation is *DwellTime*: a selection is made by looking at the target for a certain period of time [MAŠ09]. This method is effective for a stationary observer to select a stationary target, but it becomes difficult to select when the observer or the target are both moving.

There are studies that focus on selecting moving targets in a 2D display. Hasan et al. proposed *Comet* a technique that enhances targets based on their speed and direction [HGI11]. Hajri et al. proposed *Hold* method: when a user clicks the mouse button down, the

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moving targets temporarily pause [AHFMI11]. However, there is a lack of research on how to effectively select moving targets in AR. In addition, in AR, it is possible that the observer him/herself may move. Therefore, we propose methods that make selection easier even when observers and targets are both moving.

3. Method

We designed two different selection methods called *TagToPlace* and *TagAlong*. In TagToPlace, when a user gazes at an AR target, the target is fixed in the real world and stays in place. Therefore, the user can select a moving marker similar to a static target (Figure 1 center). In TagAlong, when the user gazes at an AR target, the target stays within the user's field of view, and does not move away from the field of view even if the user turns to another direction (Figure 1 right). If the user is not moving, there is no difference between TagToPlace and TagAlong. However, if the user is moving, TagToPlace requires the user to capture the target fixed in the world space by turning their head, but in TagAlong the user can look at the virtual target displayed in their field of view.

4. User Study

We compared TagToPlace and TagAlong against the DwellTime method in a task that involves selecting moving targets using head orientation. We verified the case where the target is superimposed onto non-stationary people. The target is a white circle that is superimposed on the target person's head.

We used two HoloLens for this user study. These headsets are equipped with a depth camera, an RGB camera, four environmental understanding cameras and an IMU. Both devices shared the same mixed reality space via a sharing server, which runs on a Windows 10 computer. In the user headset, a pointing cursor is displayed at the center of the field of view, and when the cursor intersects the target, which is superimposed on an target person, the target is filled with blue color gradually (Figure 1 left). Under each condition, the target can be selected by gazing at it for one second. If the gaze deviates from the target, the selection time resets to zero. In the target person's HoloLens, nothing is displayed beside being presented with instructions for starting and ending trials.

We recruited twelve (three female / nine male) participants with an average age of 33.0 years old. They have normal or corrected to normal vision. Three experimental conditions were conducted, *Stay-Move*: the user stays and the target moves, *Move-Stay*: the user moves and the target stays, and *Move-Move*: both user and target move. We applied a within-subjects design comparing a total of 3 experimental conditions $\times$ 3 methods = 9 conditions. We measured the position of the observer, the position of the target and the time spent on target selection. The experimental time was one hour including explanation, practice, and trials.

Assuming that the size of the target does not change significantly before and after the movement, we used the steering law for evaluation [AZ97]. We calculated Index of Difficulty $ID = A/W$, where A is the distance the target moved within the user's visual field from selection to completion, W is the average size of the target in the user's field of view. We also calculated Throughput $TP = ID/MT$,

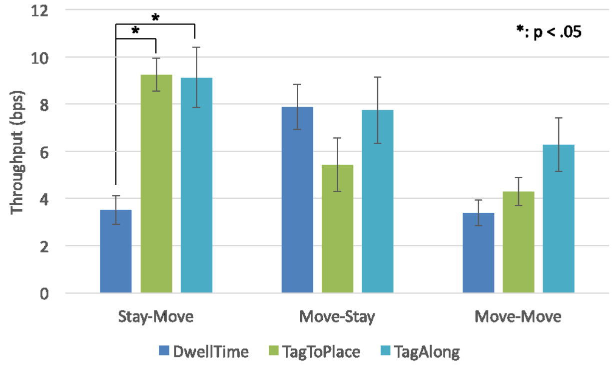

Figure 2: *The Throughput for different walking situations and selecting methods. Whiskers represent standard error (SE)*

where MT is a time when the user first saw the target until the selection is completed. The higher TP means that the target can be easily selected.

We observed that Throughput varies with the absolute difference between the experimental condition and selecting methods (Figure 2). The results were analyzed using repeated measures ANOVA and Tukey-Kramer multiple comparisons with Bonferroni correction. Overall there was a significant main effect of experimental conditions $[F(2,108) = 5.27, p < 0.01]$ and selection methods $[F(2,108) = 4.52, p < 0.05]$ on Throughput. A Tukey-Kramer test revealed that TagToPlace and TagAlong are significantly superior to DwellTime in the Stay-Move condition.

5. Conclusion

We proposed novel selection methods in AR using head orientation and evaluated the methods. Our user study shows a significant effect on the movement of users and targets in terms of Throughput. It also shows that the proposed methods are more effective in selecting moving targets than the conventional method. In the future, we intend to use the observations made in our user study to improve the interaction with the AR target and the behavior of the AR target.

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